

FIELD TESTING OF THE MARS SCIENCE LABORATORY TERMINAL DESCENT SENSOR

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ABSTRACT

The Mars Science Laboratory (MSL) will deliver a 900 kg rover to the surface of Mars in August 2012. It will utilize a new pulse Doppler landing radar, the Terminal Descent Sensor (TDS). The TDS employs six narrow-beam antennas to provide unprecedented slant range and velocity performance at Mars to enable soft touchdown of the MSL rover using a unique skycrane Entry, Descent, and Landing (EDL) technique. A key element of TDS validation and verification is field testing under realistic flight conditions and terrain. This paper describes the methods used to develop the MSL TDS field test campaign.

The test campaign convolved two considerations: the EDL flight envelope and specific flight conditions which may provoke TDS performance vulnerabilities. MSL's EDL flight envelope is much larger than other recent Mars landed missions. The radar operates from high altitude acquisition conditions (14 km AGL, 180 m/s, and 30 deg/sec) to low velocity touchdown conditions (8 m AGL, 0.75 m/s, and 0 deg/sec).

EDL flight conditions which potentially degrade TDS performance were also identified. These include altitudes, velocities, and angular rates which could provoke velocity or range ambiguities, high and low altitude performance, sidelobe interactions, terrain and temperature variations, multipath, and near-field interference.

A wide variety of test venues, aircraft types, and aircraft maneuvers were considered to place the TDS in the conditions defined above. Ultimately, three venues were selected: an F/A-18 high performance aircraft, an A-STAR helicopter, and Echo Towers at the China Lake Naval Air Warfare Center. The F/A-18, with a single-antenna TDS mounted on a single-axis gimbal in a wing-mounted pod, covers high altitude portions of the EDL flight envelope. Steep diving maneuvers mimic on-chute, initial acquisition flight conditions. The full six-antenna TDS configuration is mounted on a gimbaled platform for A-STAR helicopter testing covering the lower portions of parachute descent and powered descent. Deployment of a rover mock-up on a winch system allows characterization of any near-field interactions during skycrane. Finally, the Echo Towers, a pair of 100 m towers with a cable strung between, provide a controlled venue for assessing low altitude and low temperature performance.

To date, early breadboard and engineering model helicopter and Echo Tower tests have been conducted. Results revealed generally excellent TDS performance and one unexpected (but mitigatable) multiple bounce behavior which highlights the criticality of testing radars under real-world, flight-like conditions. The full range of helicopter and F/A-18 tests are planned for 2010 using a flight-equivalent TDS engineering model.